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ENVIRONMENTAL HEALTH SERIES

This series of reports embraces the science and technology of creating and maintaining a healthful environment for man. Individual reports in the series deal with health factors in: air; water; food; chemical, biological and radiological contamination; sound, vibration, and x radiation; liquid, solid, and gaseous wastes; homes, places of employment and recreation, and institutions.

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GEORGIA RADIUM MANAGEMENT PROJECT

James S. Benson
Richard H. Fetz
Cecil D. Posey
Earl W. Robinson

The Georgia Radium Management Project was a cooperative public health study involving the Radiological Health Service of the Georgia Department of Public Health and the U.S. Public Health Service, National Center for Radiological Health.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
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Environmental Control Administration
Bureau of Radiological Health
Rockville, Maryland 20852

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The National Center for Radiological Health was reorganized December 1968. It is now the Bureau of Radiological Health, with Dr. Raymond T. Moore, as the Acting Director.

Public Health Service Publication No. 999-RH-34

January 1969

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FOREWORD

In October 1963 the Public Health Service and the Georgia Department of Public Health jointly undertook the Georgia Radium Management Project. Shortly thereafter, Dr. Luther L. Terry, who was then the Surgeon General of the Public Health Service, announced that "a primary objective of the study is to help develop better methods for radium control by State and local health authorities throughout the country."

The project was developed in two phases. The results of Phase I and Phase II were published individually in 1966 and 1967, respectively, as program reports of the National Center for Radiological Health. This Environmental Health Series report combines both phases in a comprehensive project report. It is hoped that its publication will prove useful to all who are concerned with the control of radium used in medical practice.

John C. Villforth
Chief, Division of Medical
Radiation Exposure
Bureau of Radiological Health

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ABSTRACT

The Georgia Radium Management Project, a joint effort
ween the Radiological Health Service of the Georgia
lth Department and the Radioactive Materials Section,
ision of Radiological Health (presently Radioactive
erials Branch, Division of Medical Radiation Exposure,
eau of Radiological Health), Public Health Service,
ermined the extent of the use of radium in medicine and
radiological health problems existing as a result of
use. Basically, the investigation concerned an assess-
of (a) the extent and types of radium usage in the
tice of medicine, (b) adequacy of radiation safety pro-
res and equipment employed in handling, storing, and
g radium sources, (c) leakage of radium sources, and
contamination resulting from use of radium in medicine.
e I of the project surveyed the hospitals of Georgia,
Phase II surveyed medical offices and clinics. Radio-
cal health practices related to the use of radium in
of the hospitals were below acceptable standards. Gen-
and specific findings for radiological health practices
edical offices and clinics are presented. Hospitals,
cal offices, and clinics were generally unaware of
um contamination insurance. A study of radium contami-
on insurance is included.

Representative products and manufacturers are named
dentification only, and listing does not imply endorse-
by the Public Health Service and the U.S. Department of
, Education, and Welfare

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THE AUTHORS

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GEORGIA

RADIUM MANAGEMENT PROJECT

INTRODUCTION

Harmful effects resulting from the use of radium were recognized shortly after its discovery in 1898. Even though these effects were recognized early, it was only in recent years that the nature and extent of the problem of radiation exposure were fully realized. This realization has produced increasing interest in the radiological health aspects of the use of radium on the part of health agencies; however, in 1963 the regulatory control of radium was still limited, and as a result: (1) there was insufficient knowledge concerning the radiological health aspects of the medical use of radium and (2) techniques and procedures for the survey of medically used radium had not been extensively developed and tested. In order to help alleviate this situation, the Georgia Department of Public Health, and the U.S. Public Health Service initiated the Georgia Radium Management Project.

The project, a joint effort between the Radiological Health Service of the Georgia Health Department and the Radioactive Materials Section, Division of Radiological Health, Public Health Service, had two objectives: to determine the extent of the use of radium and the extent of radiological health problems existing as a result of this use. The Project, which was developed in two phases, began in October 1963 and was completed October 1965. The first phase involved the survey of radium used in the hospitals of Georgia and was completed in December 1964. In January 1965, Phase II was initiated. This latter phase was directed toward the use

of radium in private medical offices and clinics. It was completed October 1965. Basically, the investigation concerned an assessment of (a) the extent and types of radium usage in the practice of medicine, (b) adequacy of radiation safety procedures and equipment employed in handling, storing and using radium sources, (c) leakage of radium sources, and (d) contamination resulting from use of radium in medicine.

PHASE I

PROJECT PLANNING

The initial step in undertaking this project was to identify those hospitals using radium. A questionnaire requesting pertinent information related to radium usage was sent to all hospitals licensed in the State. Responses to the questionnaire showed that 24 hospitals owned or leased radium, and that an additional 40 allowed it to be used in their facility.

A lengthy survey form was designed so that all pertinent data could be recorded. As surveys were made, the form was revised to a more convenient checklist with a few blank sheets of paper for recording data. All of the data covered by the checklist were useful during the project. Only those data of general interest are included in this report.

Since one of the objectives of the project was to determine the extent of leaking sources in use, a leak test method suitable for field use was required. Investigation of the problem of leak testing in the field led to the development of a new leak test technique (1).

FIELD SURVEY PROCEDURES

The survey procedure at each hospital was similar. It can be separated into three phases:

1. THE APPROACH. The hospital administrator was telephoned and informed of the pending survey. He was asked who was responsible for the radium. That person was then contacted and a convenient time for the survey arranged. The local county or city health department was informed of the pending survey.

2. THE SURVEY. Upon arrival at the hospital, the surveyors explained the purpose of the survey to the hospital administrator and the person responsible for the radium. After background information was obtained and recorded, the monitoring portion of the survey began.

The following instruments and equipment were used during the surveys:

a. Portable alpha survey instrument (Eberline PAC-3G).

b. Gamma survey instrument with a high-range capability (Eberline E500B).

c. Leak test apparatus (Jar Method).

d. Miscellaneous equipment (disposable gloves, plastic bags, forceps, masking tape, and so forth).

Alpha-ray and gamma-ray monitoring were done concurrently to avoid walking into contaminated areas or improperly shielded storage areas. Areas, such as the floor (spot check), storage container, working surfaces, and applicators, were monitored for alpha-ray contamination. Gamma-ray readings were taken with special attention paid to personnel who might have been exposed as a result of improper radium storage.

Handling equipment and accessories, such as forceps, L-block, source transport, and so forth, were observed and a judgment was made as to their adequacy. Frequency of radium usage and source transportation between storage were considered.

A leak test completed the survey. The person who normally handled the radium in the hospital was asked to place the sources in the leak test jars. This not only relieved the surveyors of the responsibility of handling the sources, but also enabled them to observe the radium handling techniques.

Since the leak test required a 24-hour radon collection period, the surveyors returned the following day to complete the test. (Jars were sent to some of the hospitals prior to the survey so that hospital personnel could place the

sources in the jar the day before the survey. If desirable, the survey could be completed in 1 day.) The person responsible for the radium was verbally informed of any recommendations the surveyors thought advisable.

3. WRITTEN REPORT. As a final part of the field survey, a written report was mailed to the hospital administrator. Copies were sent to the person responsible for the radium and to the appropriate local health department.

FINDINGS

EXTENT OF RADIUM USE

The surveys were limited to 24 hospitals that owned or leased radium. These hospitals ranged in size from 36 to 1,000 beds. The frequency of radium treatments in each hospital was independent of its size, and varied from one per year to 100 per year, with a total of 898 per year in all 24 hospitals (table 1).

The amount of radium at each hospital ranged from 50 milligrams to 440 milligrams. These inventories consisted of needles, tubes, cells, and plaques. (The distribution of sources is given in table 2.) In all, there were 787 sources containing 3,725 milligrams of radium. Some of the sources were new, while others were 35 years old. If the actual age was unknown, it was recorded as the length of time the radium was in possession of the facility being surveyed; therefore, in some cases, the actual ages may be more than those shown in table 1.

RADIUM LEAKAGE

Eight of the 24 hospitals were found to have one or more leaking sources. (An arbitrary value of 1,000 counts

Table 1. Summary of radium facility survey data

Hospital	Bed size	Number of sources	Activity	Leakage			Storage adequacy		Contamination			Use frequency (per year)	Age (yrs)
				Yes	No	Questionable	Yes	No	Gross	Slight	None		
A	1,000	80	440		x		x			x		75	2-15
B	514	14	195	x			x			x		50	30
C	500	20	200	x			x		x			100	10
D	450	60	90		x			x			x	2	3
E	400	147	300			x	x			x		100	5-10
F	385	9	90		x		x			x		12	3
G	350	69	315		x		x				x	70	10-20
H	350	12	100		x		x				x	--	New
I	300	54	240		x		x			x		50	10-20
J	300	26	110		x		x				x	10	30+
K	280	19	100			x	x			x		5	10
L	270	12	100	x			x		x			25	15
M	250	9	90		x			x		x		12	15
N	200	39	144		x			x		x		50	20
O	190	20	100	x				x	x			85	35+
P	190	40	137	x			x			x		90	14
Q	161	75	250	x			x			x		40	18
R	147	9	150		x		x			x		12	6
S	139	7	85		x		x				x	40	7
T	131	37	164	x				x	x			20	30
U	127	10	100		x			x			x	10	10
V	109	10	100		x		x				x	36	1
W	66	4	50			x		x			x	1	30
X	36	5	75	x				x		x		3	35
Total		787	3,725	8	13	3	16	8	4	12	8	898	

Table 2A. Radium source distribution by activity and hospital - needles

Hospital	Number of needles with radioactivity of: 0.5	0.66	0.75	1.0	1.33	1.5	2.0	2.25	2.4	3.0	3.3	5.0	10.0	12.5	Total needles	Total activity (mg)
A				10		10		4			4				28	45
B												4	5		9	70
C													20		20	200
D	10			20		10	10			10					60	90
E															0	0
F													9		9	90
G			5			6		4			4	6			25	65
H												4	8		12	100
I				10			10			6	5	20			51	165
J		6			8				2						16	20
K				5			5								10	15
L												4	8		12	100
M													9		9	90
N				9			9			9		6	6		39	144
O				9								8		2	19	75
P				5			5					1	3		14	50
Q															0	0
R															0	0
S															0	0
T				10			12					4	11		37	164
U													10		10	100
V													10		10	100
W															0	0
X														4	4	50
Total	10	6	5	78	8	26	51	8	2	25	13	57	99	6	394	1,733

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Table 2B. Radium source distribution by activity and hospital - tubes and plaques

Hospital	Number of tubes with radioactivity of:									Total tubes	Total activity	Number of plaques with radioactivity of:		Total plaques	Total activity (mg)
	5	6	10	12	12.5	15	20	25	50			5	10		
A			10				3	2		15	210				
B									2	2	100	1	2	3	25
C										0	0				
D										0	0				
E			11			7		1		19	240				
F										0	0				
G										0	0				
H										0	0				
I								3		3	75				
J		5		5						10	90				
K	1		8							9	85				
L										0	0				
M										0	0				
N										0	0				
O								1		1	25				
P										0	0				
Q										0	0				
R			5					4		9	150				
S	3					3		1		7	85				
T										0	0				
U										0	0				
V										0	0				
W					4					4	50				
X								1		1	25				
Total	4	5	34	5	4	10	3	13	2	80	1,135	1	2	3	25

Table 2C. Radium source distribution by activity and hospital - cells

Hospital	Number of cells with radioactivity of: 0.33	0.66	3.33	5.0	10.0	Total cells	Total activity (mg)
A				37		37	185
B						0	0
C						0	0
D						0	0
E	74	54				128	60
F						0	0
G			24	6	14	44	250
H						0	0
I						0	0
J						0	0
K						0	0
L						0	0
M						0	0
N						0	0
0						0	0
P			26			26	87
Q			75			75	250
R						0	0
S						0	0
T						0	0
U						0	0
V						0	0
W						0	0
X						0	0
Total	74	54	125	43	14	310	832

per minute alpha on the jar lid using the portable alpha survey instrument was assigned to define leakage.) Three additional hospitals had one or more sources that yielded count rates above background, but below the 1,000 counts per minute level. These sources were presumed to be either leaking at a low rate or were contaminated on the surface with radium 226. If these three facilities are included with the other eight, then 46 percent of the hospitals surveyed had suspect sources. This percentage is high but not surprising, since only five of the hospitals routinely performed leak tests.

Persuading users to have leaking sources reencapsulated was often difficult because of the high cost (almost as much as the cost of new sources) and because radium companies are reluctant to handle sources of unknown manufacture. The term "reencapsulation" is a misnomer in this context. Usually, when sources are returned for reencapsulation, they are exchanged for new ones. The radium in the old sources may be recovered and used in the production of new sources. Persuading users to dispose of sources no longer wanted or needed was also a problem because there is little or no market for used sources. This disposal problem did not exist where sources were leased. If leased sources were no longer wanted, the user simply returned them to the leasing company.

RADIUM CONTAMINATION

In 12 hospitals, the contamination was less than 2,000 disintegrations per minute per 100 cm^2 or was found in only one or two small spots in the storage area. On the other hand, one hospital (Americus and Sumter County Hospital) was contaminated from the basement to the top floor (2). Levels ranged up to 1 million disintegrations per minute per 100 cm^2. Decontamination operations required consultation with health

physicists and took 5 weeks. A 10-milligram radium needle was broken in the x-ray department and contamination was spread throughout the hospital by personnel walking through this area. In addition to this hospital, three other hospitals required the services of a health physics consultant to decontaminate. The remaining 12 hospitals were either decontaminated by their personnel or the levels were considered to be within tolerable limits. What was considered to be "tolerable" presented a problem, since no clear-cut limits for surface contamination exist. The amount of contamination, the size of the area contaminated, the type of contamination (radium 226, short-lived daughters or long-lived daughters), the physical characteristics of the area contaminated, and the probability of transfer of the contamination were some of the criteria considered in making a decision as to whether decontamination was necessary. In general, if levels were above 2,000 disintegrations per minute alpha per 100 cm^2, decontamination was recommended.

Two observations were made as a result of the contamination incident at the Americus and Sumter County Hospital. First, a user should have someone to contact for immediate help in case of an emergency. Users at facilities surveyed following this incident were told they could contact the State health department, and State personnel would be sent to the area in question immediately. Second, the hospital where the incident occurred had no contamination insurance (none of the hospitals surveyed did). If the State health department and the Public Health Service had not aided in the decontamination, the hospital would have been in serious financial trouble. Hospital administrators of subsequent facilities surveyed were informed of this insurance problem. It was recommended they investigate the possibility of obtaining insurance that would cover the costs of decontamination (See Phase II - Study of Radium Contamination Insurance).

RADIUM STORAGE

Inadequate radium storage resulted in gamma-ray levels above acceptable limits at eight (33 percent) of the hospitals. The acceptable exposure limits used for the surveys were: (a) 2 milliroentgens per hour for uncontrolled areas, (b) 100 milliroentgens per week for occupationally exposed personnel. The cashier at one of the eight hospitals was exposed to an estimated 1 to 2 roentgens per week from radium stored unshielded in a supply cabinet.

RADIUM HANDLING TECHNIQUES

Data on handling techniques were difficult to obtain since the surveyors could not observe the routine handling of radium; however, the users were asked to place their sources in the leak test jars. In this manner, the surveyors were able to get an impression of handling techniques. When the user handled the sources with his fingers or used lead gloves and a lead apron for protection, it was obvious that improved techniques were needed. Hopefully, through a discussion of the characteristics of radium (its high gamma-ray energy, for example) with the user, these improvements would be made.

ACCOUNTABILITY

Accountability of radium was a problem in most of the hospitals. In most instances it was difficult to find out who actually owned the radium or who was directly responsible for it. In general, when several people had access to a radium inventory and no one person was directly responsible for it, the radium had a higher probability of getting out of control; for example, in one hospital when the radium

was removed from a patient at night or on a weekend, it was placed on a table. It stayed there until a technician reported for work on the following weekday to clean and return the radium to storage. While the radium was lying on the table, uncontrolled, several people could have received high gamma-ray doses from it or it could have been easily lost.

RECOMMENDATIONS TO USERS

Because no formal regulations covering radiation existed in Georgia, the surveys were conducted on a voluntary basis, and findings were written as recommendations rather than orders for compliance. Most of the users agreed to follow these recommendations. The degree to which the recommendations were followed will be determined through followup surveys. Some examples of the recommendations made to the users were: (a) leak test the radium periodically, (b) the use of leaded glass in L-blocks less than 1/2-inch thick, and the use of lead gloves and aprons be discontinued because these items offer little or no shielding, (c) the user and his employees wear film badges, and (d) radiation warning signs be posted around radium storage areas. It was also recommended that these signs list the telephone numbers of representatives of the State health department to be called in case of an emergency.

CONCLUSION

The results of the study showed that the radiological health practices related to the use of radium in most of the hospitals surveyed were below acceptable standards. Only 5 hospitals out of the 24 surveyed had no leaking sources, had adequate radium storage, and were free of contamination. Although many improvements were needed to bring the safety

programs at the hospitals to an acceptable level, the users were generally anxious to make these improvements when the reasons for them were explained. The surveyors took as much time as was needed to explain why a problem existed and how to correct it. This user education approach was successful throughout the study, and it was planned to continue it during subsequent surveys.

PHASE II

PROJECT PLANNING

OBJECTIVES AND PURPOSE

The objectives of Phase II were to:

1. Locate, identify, and survey the radium used in private medical offices and clinics in Georgia;

2. Develop and test procedures and techniques for the survey;

3. Obtain voluntary compliance with minimal radiation safety standards; and

4. Develop an official report on the activities, findings, and conclusions.

In order to accomplish these objectives, it was necessary to locate and identify all private medical practitioners in the State who own, lease, or store radium. For this reason, a radiation source inventory was made.

RADIATION SOURCE INVENTORY

Preliminary Planning

The following basic decisions were made in relation to the inventory:

1. A voluntary inventory would be made rather than use the registration approach since: (a) it was decided to avoid legal overtones in the first approach to the private practitioners and (b) the necessary registration regulation had not been promulgated by the Georgia Department of Public Health.

2. All radiation sources belonging to private medical

practitioners would be included in the scope of the inventory rather than limiting it to radium only. In this way, additional information on radiation sources could be obtained. The increased scope would not add significantly to the Project workload since all licensed physicians in the State would have to be contacted in either case.

3. The formal sanction of the Georgia Medical Association would not be requested since the Medical Association is represented on the Georgia Radiation Control Council which had sanctioned the Project.

4. The inventory form would be as brief as possible asking only for essential information. It was felt that this approach would assure the greatest response.

Procedures

The following procedures were used in the Radiation Source Inventory:

1. A brief one-page explanatory letter to be sent to each physician in the State was prepared (attachment A).

2. A stamped, self-addressed post card inventory form to be completed and returned by the physician was also prepared (attachment B).

3. A serially ordered number was assigned to each physician in the State. This number was recorded on a master list as well as on the inventory form sent to the physician.

4. The initial letter with post card inventory form was mailed to licensed physicians in the State on January 15, 1965.

5. On February 16, 1965, a followup letter similar to the initial inventory letter (attachment C) was mailed, with a second copy of the inventory form, to physicians who had not responded to the initial letter.

Results

Table 1 shows the basic information obtained from the

Table 1. Georgia radiation source inventory

Item	Original		Followup		Combined total	
	Number	Percent	Number	Percent	Number	Percent
Cards mailed	2,832	100	548	100	2,832	100
Cards returned	2,284	81	331	61	2,619	93
Physicians who use, own, lease, or store:						
X-ray producing equipment	921	41	153	49	1,074	42
Radium	86	4	12	4	98	4
Other radioactive material	33	2	11	4	44	2
Physicians who have in the past owned, leased, or stored radium	24	1	4	1	28	1
Return mailing address completed	1,148	51	156	50	1,304	51
Office phone number recorded	2,099	94	287	91	2,386	93
Office address given	2,009	90	273	86	2,282	89

inventory. The overall response (93 percent) was far better than anticipated and certainly a satisfactory response for a voluntary program.

It was apparent from information obtained during Phase I of the Project that many physicians who reported ownership or lease of radium were actually reporting previously surveyed radium belonging to or used at hospitals. These responses were eliminated.

Twenty-eight physicians who did not own, lease, or store radium but who reported that they had previously done so were contacted in order to obtain additional information. Of these 28, it was found that nine had made a mistake in completing the card since they did not actually own, lease, or store radium. Thirty-six physicians who reported merely the use of radium where determination of the actual owner or lessee could not be made were also contacted by telephone. Through this procedure, five additional radium owners were identified. Two physicians who occasionally purchase radon seeds were also identified.

Table 2. Radium or radon possession by medical specialty

Specialty[a]	Number of physicians possessing radium or radon
Eye, ear, nose and throat	9
Dermatology	5
Surgery	10
Radiology	3
General practice	2
All others	3
Total	32

[a]Medical specialty obtained from the roster of the Georgia Medical Association.

The final radium and radon inventory determined that 28 physicians permanently maintained radium supplies, one leased radium on a "per case" basis, and three occasionally purchased radon seeds. Ownership or lease of radium by medical specialty of physician is shown in table 2. Surgeons were the predominant possessors of radium in private practice followed by eye, ear, nose and throat specialists.

Critique

The inventory technique was successful and the total response was greater than expected. The simple inventory approach using a brief post card type form proved to be very effective.

Data processing was not used during the inventory. Although it might have saved labor and time in data tabulation and analysis, its use would have meant an unacceptable delay in initiating the inventory because of the preparation that would have been required.

The inventory form proved to have several shortcomings; for example, physicians may report the same radiation source if it is jointly owned or leased. A place on the form for indicating joint ownership would have been desirable.

If a physician checks "use" under question number 2 on the form, there is no place for him to indicate whose radium is used and where it is used. Since the purpose of including the word "use" in question 2 was to help locate radium that may not have been otherwise reported, the physician who reported radium "use" had to be contacted and the necessary information obtained.

There is just so much information that can be obtained by using a post card size form and the original thinking was to keep the form as brief as possible; therefore, clarification of information had to await further contact, either through correspondence, a telephone call or a personal visit.

At least the information obtained from the inventory indicated who should be contacted and how they may be contacted.

Radiation Survey Forms

During Phase I of the Georgia Radium Management Project, a radium survey form was developed and used. The form was 15 pages long and it was soon realized that it was unwieldy and difficult to use. At the end of Phase I, the project surveyor developed a simple checklist to replace the radium survey form.

As an alternative approach, a survey form was developed to be used in combination with a checklist. The "checklist" indicated on one page most of the information to be obtained during the radium survey. The "survey form" provided specific spaces to record the information obtained. It was made as brief as possible through elimination of information of doubtful value and the maximum use of the available space on each page.

Both these approaches were tested during the initial stages of the field portion of Phase II. After 12 field surveys, the combination "checklist" and "survey form" was selected for use during the remainder of the project. A completed copy with identifying names removed is shown on attachment D.

The following is an explanation of the radium "survey form" and "checklist" selected for Phase II:

1. The survey form is divided into nine major sections.

a. General - Identification and general information.

b. Radiation Safety - Questions on personnel monitoring, medical examinations, radiation instruments and radiation exposure control when the radium is in use.

c. Source Description - All available information on the facility's radium sources.

d. Source Security - Questions related to measures taken to prevent loss or unauthorized removal of radiation sources.

e. Source Storage - Relates to the source storage area and radium storage vault or container. It also includes questions concerning warning signs and posted emergency instructions.

f. Source Preparation and Transportation - All questions concerning the handling, preparation, and transportation of the sources.

g. Area Survey - Tables for recording the results of the radioactive contamination survey and the gamma exposure level survey that are a normal part of a radium survey. The use of a table saves time in recording data.

h. Leak Test Data - Results of leak tests performed during the survey.

i. Sketch - A sketch of the radium storage area, preparation area, and surroundings is made in the space provided. Numbers identifying the location of contamination and gamma exposure measurements recorded under "Area Survey" are recorded on the sketch.

2. A blank space is provided on the form for recording the information called for by the checklist. These blank spaces are numbered and lettered exactly as the requested information on the checklist is numbered and lettered.

3. If more space for recording survey information is needed, the backs of the survey form pages provide ample space.

Field Survey Procedures

RADIUM FIELD SURVEY

The procedures for performing radium field surveys were essentially the same as those used during Phase I. The sur-

vey was made by a two-man survey team. It was found that a two-man team could perform the survey quickly and smoothly with a minimum of inconvenience to the physician.

The survey was conducted on a voluntary basis since regulations had not yet been promulgated under the Georgia Radiation Control Act (Chapter 88-13 of the Georgia Health Code).

The following is a brief description of the survey procedures used:

1. A physician whose office was to be surveyed was contacted by telephone and an appointment was made. The physician was told why the State was making the survey, given a brief description of the survey, told about how long the survey would take, and how long his radium would be out of use. Efforts were made to arrange appointments and work schedules so the physician would have the least possible inconvenience.

2. Upon arrival at the physician's office, a second explanation for the survey was given to the physician. If he was interested and responsive, the physical hazards associated with radium use were discussed in more detail and any questions he might have were answered. Special care was also taken to point out the advantages of insurance coverage for radioactive contamination.

3. The survey team then interviewed the physician while completing pages 2 and 3 of the Radium Survey Form. The survey questions were asked by one team member only in order to preserve continuity of questioning. At the conclusion of the interview, the other team member was given the opportunity to ask questions or clear up any doubts he might have.

4. After completing the interview, the survey team conducted a radiation survey of the facility. While one survey team member made a sketch of the radium storage and

the surrounding area, the other set up the survey instruments and proceeded to complete those portions of the survey form related to source storage, preparation, and transportation. Frequently a nurse or an assistant to the physician was able to assist the surveyors during this phase of the survey and there was no need to further occupy the physician's time.

5. One team member made the area survey measurements, which included alpha contamination measurements as well as gamma exposure level measurements, while the other recorded the readings on the survey form. Area survey measurements were made with an Eberline PAC-3G and an Eberline E-500B. Backup instruments were always taken on each survey as well as extra batteries and counting gas. A personnel monitoring device, which emits an audible signal, was also found to be quite useful since unsuspected radiation fields were occasionally encountered.

6. Following the area survey measurements, the radium sources were leak tested using the jar test method. The surveyors had originally intended to have the physician or an assistant load and unload the leak test jars in order to avoid any possible legal consequences resulting from the survey personnel handling the sources; however, they decided to handle the sources themselves when performing leak tests for the following reasons:

a. Difficulty was often encountered in getting someone at the facility to load and unload the leak test jars, and

b. It was desirable to determine radiation exposure data for personnel using the jar leak test method, and it was much easier to do this if the surveyors performed the leak test.

When space and shielding permitted, each source was leak tested individually. Lead bricks were routinely carried along on each survey to provide additional shielding. When leakage was found, the source was resealed in its respective

jar to prevent the spread of contamination and th
returned to storage. This also allowed subsequen
fication; however, resealing the sources in jars
made it necessary for the State to loan lead bric
facility in order to accomplish safe storage.

At times, the physician's total radium suppl
be individually leak tested because of the diffic
viding adequate shielding for all the leak test c
that would be required. Leak testing of subgroup
necessary. When subgroup leakage was indicated,
of that group were then individually leak tested
determine the actual leaker or leakers. Such a p
not followed, however, if it was felt that furthe
testing of the group of sources in question would
hazardous because of high leakage rates.

7. Photodocumentation was an integral part
survey. A Polaroid camera was used to photograph
area and other areas of interest at the conclusio
testing, after prior approval had been obtained f
physician.

8. At the completion of the survey, the su
then talked to the physician again to summarize b
survey findings and to discuss the correction of
ciencies or hazardous conditions found.

RADIUM FIELD SURVEY REPORTING

Two types of reports were made after each ra

1. <u>Report to the File</u> - This report, in na
is divided into the same subheadings as the Radiu
Form. Its purpose is to record, as fully and wit
detail as possible, all information obtained and
tions made during the radium survey. A narrative
made, rather than merely completing the survey fo
reasons stated below:

a. A comprehensive narrative survey report provides further assurance that all significant information will be recorded.

b. It presents the survey findings in a more readable manner than a survey form.

c. It gives an individual who might have an occasion to review the report, but who did not perform the survey, a better "feel" for the facility than a completed survey form alone.

A copy of this report for a typical survey is shown on attachment E.

2. Report to the Facility Surveyed - The physician responsible for the facility was sent a written report covering the results of the radium survey. This report included recommendations for correcting major deficiencies found. The philosophy of correcting only major deficiencies, adopted during Phase I of the Project, was continued during Phase II. A copy of a typical report to a private physician is shown on attachment F.

FINDINGS

SURVEYS

Radium belonging to 25 private physicians was surveyed during the Georgia Radium Management Project (table 3). Twenty-four surveys were made during Phase II and one survey was made, at request, during Phase I.

Although Phase II was devoted to the survey of radium in private medical offices, it was necessary to make surveys of three hospitals during this phase (table 3). One of these was a resurvey of a hospital previously surveyed during Phase I. The other two hospitals surveyed were hospitals which, for various reasons, could not be surveyed during Phase I.

Table 3. Completed radium surveys

Survey	Phase I		Phase II	
	Hospitals	Private physicians	Hospitals	Private physicians
Regular	22	1	3	24
Other	0	[a]1	[b]1	[c]2

[a]Retired.

[b]Radium not used.

[c]One retired and one deceased.

Eight radium facilities were not surveyed or were incompletely surveyed for the reasons stated below:

1. Three physicians who leased radium on a long-term basis were returning their radium to the company.

2. The radium of a hospital radiology group was only partially surveyed because a new radium storage facility was under construction, and the State chose to defer the completion of the survey.

3. One private physician who leases radium on a per case basis and uses it only at a hospital was not surveyed because he leases it infrequently.

4. Three private physicians who purchase radon seeds to be used at hospitals were not surveyed because they do so only occasionally.

GENERAL FINDINGS

User Attitude and Program Acceptance

One of the most important aspects of any radium control program is the attitude toward the program assumed by those who possess and use radium sources. The survey personnel made it a point to avoid the connotation of governmental control both in the initial and subsequent contacts with the

user. The approach to the user was as follows: "The State is providing you with a valuable service that will determine (1) whether your radium storage container is adequate to assure the safety of yourself and your staff and (2) whether your radium sources are leaking radium and/or radon gas which could also be dangerous to you and your staff."

Using this approach, the surveyors were able to gain entrance to every radium facility to be surveyed. In only one instance was any initial difficulty encountered. When it existed, initial indifference and, in a few instances, slight suspicion or hostility was overcome before the end of the survey.

Personal contact with each radium user, which provided the opportunity to explain the State's radiological health program and to indicate the hazards associated with the medical use of radium, was undoubtedly one of the more important and beneficial aspects of the Georgia Radium Management Project.

Radiation Safety Orientation and Training

The amount of radiation safety orientation and training of personnel using radium will largely determine the quality of radiation hygiene practiced in the facility; however, the radiation safety orientation and training of the user and his staff is perhaps the most difficult factor to ascertain during a radium survey.

The physicians seemed to have very limited knowledge of radiation safety and the hazards of using sealed radium sources. This was especially true of shielding requirements and leakage from sealed radium sources. One physician, for example, was using as a radium transport device a small 1/16-inch (wall thickness) lead box which he carried in his hand. Another physician was unaware that his radium needles contained radium in powder form. He had been using a needle

that had been accidently cut open several years ago. The occurrence of these and the other hazardous situations could be prevented if users were better informed of the physical and chemical properties of radium and the construction of radium sources.

Some physicians surveyed during Phase II showed little apparent apprehension over needlessly exposing their patients and members of the public to radiation fields. It was the rule rather than the exception that patients receiving dermatological treatments with radium were either asked to wait in the patient waiting room during such treatments or were allowed to leave the office and go home. The authors observed a patient sitting in a waiting room while being treated with 50 milligrams of radium needles taped to her face. There were at least six other people in the room. The distance from the patient to the nearest individual was approximately 18 inches. The calculated exposure at this distance is 200 mR during a 1-hour period. The use of a 10-milligram radium plaque would result in an exposure of 40 mR per hour under these same conditions.

These findings indicate the physician's lack of knowledge of radiation safety principles; therefore, the user education aspects alone will justify the time and effort expended on a radium survey.

In most instances, it was found that the physician handles the radium and his nurse or assistant has very little actual contact with it. A few physicians, however, allow their nurse or assistant to remove radium from patients at the end of the treatment period.

If the physician has little knowledge of radiation safety, he cannot be expected to impart such knowledge to his assistants. In only one instance was a knowledgeable assistant found. This person acted as the source custodian and performed all source preparation operations.

Radioactive Contamination Insurance

Numerous and costly incidents involving extensive radioactive contamination have occurred in radium facilities. No facility surveyed during Phase II carried specific radioactive contamination insurance. Many physicians thought that they were covered by their professional liability insurance. The surveyors were initially lacking in sufficient knowledge of this aspect of the insurance field to give radium users useful information and advice regarding radioactive contamination insurance. Efforts to obtain information from local insurance agencies were unsuccessful, since the local agencies also had little knowledge of the subject. As a result, the Georgia Department of Public Health contacted the home office of major insurance companies and obtained the information (see Study of Radium Contamination Insurance).

Prior Radium History Information

Physicians who reported prior ownership or lease of radium on the radiation source inventory card were contacted to obtain the following information:

1. Date of radium acquisition.
2. Date of radium disposal.
3. Type of sources possessed.
4. Type of radium possession (per case lease, long-term lease, or owned).
5. Disposal of radium, if owned.

This information is given in table 4.

Most of the physicians who have terminated their radium possession have done so in the last 15 years (table 4). This was during the period when the rate of acquisition of radium by private physicians was decreasing. This seems to indicate that the use of radium by private physicians is declining. A specific decrease in the use of nasopharyngeal applicators was noted. Seven physicians leasing nasopharyn-

Table 4. Prior radium history data

User's medical specialty	Radium treatment or source information	Radium ownership	Radium acquisition date	Radium disposal or termination date	Radium disposal method
General practice	5 - 10 mg needles	Owned	1924	1960	Given to local physician
E, E, N, & T	Nasopharyngeal applicator	Long-term lease	?	(Within last 5 years	Returned to company
Radiology	Could not be contacted				
Surgery	Needles	Per case lease	?	1955	
E, E, N, & T	Nasopharyngeal applicator	Per case lease	?	1950-1955	
Surgery	Treatment of cancer of cervix & uterus	Per case lease	?	1960	
E, E, N, & T	Nasopharyngeal applicator (assumed)	Long-term lease	?	1945	
Urology	?	Per case lease	?	1960	

Table 4. Prior radium history data (continued)

User's medical specialty	Radium treatment or source information	Radium ownership	Radium acquisition date	Radium disposal or termination date	Radium disposal method
Gynecology	Treatment of cancer of cervix & uterus	Long-term lease	1954	1957	Returned to company
General practice	120 mg	Owned	?	1952	Sold to physician
Radiology	Loaded applicators for cancer of cervix	Per case	?	1962-1963	
E, E, N, & T	50 mg nasopharyngeal applicator	Long-term lease	1956	1960	Returned to company
Surgery	50 mg	Long-term lease	?	1962	Returned to company
E, E, N, & T	Nasopharyngeal applicator	Long-term lease	1955	1963	Returned to company
Radiology	2 - 10 mg needles 1 - 10 mg plaque	Owned	?	1955	Sold
E. E. N. & T	50 mg nasopharyngeal applicator	Long-term lease	1945	1960	Returned to company

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Table 4. Prior radium history data (continued)

User's medical specialty	Radium treatment or source information	Radium ownership	Radium acquisition date	Radium disposal or termination date	Radium disposal method
E, E, N, & T	Nasopharyngeal applicator	Long-term lease	?	1955	Returned to company
Surgery	?	Per case lease	?	1939-1940	
General practice	33 - 3.33 mg cells	Owned	1939	1951	Sold to physician

geal applicators have terminated their leases, and most of these were terminated in the last 10 years. The field surveys also indicated a definite decline in the nasopharyngeal use of radium.

Radium Incidents

Although the detailed collection of radium incident information was not considered to be within the scope of the survey, the surveyors did make an effort to determine whether incidents had occurred at each installation surveyed. In general, there was not time to pursue in detail each reported incident. A total of seven radium losses, one theft, and one source rupture was identified. One radium loss was discovered during the survey of a radium facility. When the radiologist looked for a capsule containing several 3.3-milligram cells, he failed to find it and did not recall having actually seen it for the past 6 or 7 years. A thorough search of the storage area and trash system was made, but the sources could not be located. This points out the need for adequate source accountability procedures so that radium losses may be promptly discovered, and efforts to find lost radium may be initiated without delay. There was also an obvious need for improvement in radium use and handling procedures in order to prevent such losses from occurring.

SPECIFIC FINDINGS

Radium Treatment Data

Table 5 shows the types and number of radium treatments provided by the 25 private physicians surveyed in Georgia, as well as the number of physicians providing each type of treatment.

Dermatological treatments were provided by 18 of the 25 private practitioners using radium. The number of these treatments was estimated to be approximately 1,300 per year.

The reason for the uncertainty of the treatment frequency data is that only the total number of treatments were determined for an installation, including those providing more than one type of treatment.

Table 5. Radium treatment type and frequency

Type of treatment	Physicians providing	Total number provided (per year)
Nasopharyngeal	6	44
Eye	1	12
Dermatological	18	[a]1,300
Interstitial	2	[a]44
Gynecological	10	[a]700

[a]Estimated.

Although the exact number of dermatological treatments was not obtained, the number of dermatological treatments provided was a majority of the total. This fact is counter to the widespread opinion that the dermatological use of radium is a thing of the past.

Figure 1 shows the approximate dermatological treatment frequency distribution for dermatologists and nondermatologists (mostly surgeons). Eighteen physicians provided dermatological treatments, although only five were dermatologists. Of these 18 physicians only nine possessed plaques (table 6). More than one-half of the dermatological treatments were provided by 10 physicians. Radium needles and tubes taped directly to the skin of the patient were used.

The hospitals surveyed during Phase I and II provide a total of 900 treatments per year. It is therefore apparent that private practitioners provide more than twice this number of radium treatments. This is an unexpected finding, and indicates that perhaps radium survey priority should be

Given to the survey of the radium possessed and used by private physicians rather than hospitals.

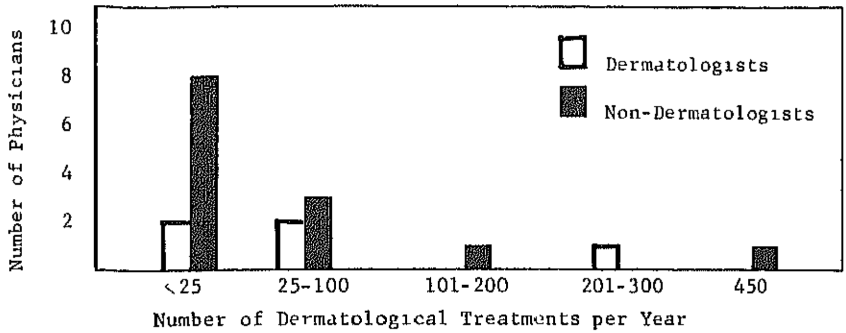

Figure 1. Dermatological treatment frequency distribution

Use of Other Radioactive Material

Four of the private physicians surveyed had AEC licenses. Two other physicians used thorium-X occasionally for dermatological applications. Only one of the facilities surveyed had AEC licensed radioactive material of such hazard to justify frequent AEC inspections. This facility was judged to have the best radiation safety program of any facility surveyed during Phase II.

Use of Radium Outside the Facility

Of the 25 physicians surveyed, 10 used their radium not only at their own office but at one or more local hospitals as well. The fact that a physician's radium is used at one or more hospitals in addition to his own office will complicate a health agency's efforts to promote and obtain the safe use of radium, since the hospital and its employees would not be under the control of the physician. On the

other hand, the hospital administration might be able to correct hazardous situations related to a physician's radium where the physician might not be inclined to do so; for example, it was discovered during a radium survey that a physician routinely stored his radium at a hospital. The storage location was not marked, nor was it a good one. It was found that the radium had contaminated the storage area. Through the efforts of the administrator, a better storage location was obtained.

Radiation Safety During Patient Treatment

Only 10 physicians isolated patients undergoing radium treatment. Patient isolation in this instance means placing a patient in a separate, unoccupied room so that the nearest approach to the patient can be controlled. Patient isolation information could not be accurately determined for seven physicians; however, based on the previous experience of the surveyors, it is probable that most of these physicians did not always isolate their patients. Patient isolation in a hospital was mostly determined by the patient's ability to pay for a private or semi-private room. Charity cases were usually placed in the wards. It was also found that special tags or radiation warning signs were never placed on or near hospitalized patients receiving radium treatment.

Dermatological treatments were given at the physician's office if the patients were ambulatory. Gynecological applications were always made in hospitals. Dermatology patients were either kept in a separate room, asked to wait in the waiting room, or allowed to leave the physician's office, depending on the available space, patient load, and the physician's attitude. Most commonly, the patient was told to wait in the waiting room or to go home and return at the time the radium was to be removed.

Having a patient wait in a waiting room and needlessly exposing other patients is undesirable from a radiation

safety standpoint. If a patient undergoing radium treatment is allowed to leave the physician's office, the radium is no longer under they physician's control. This is an even more hazardous situation. Physicians who made a practice of this reported losses and theft of their radium as a direct result. Such occurrences did not cause them to discontinue the practice.

Nurses or other attendants were only required for hospitalized patients receiving radium treatments. Only 10 physicians provided radium treatments that required hospitalization of the patient. Of these, only one made an effort to assure that the nurses attending his patients were properly informed concerning the radiation hazard involved. In no case did the physician or hospital provide the nurse-attendants with radiation exposure monitoring devices.

Radiation Exposure Monitoring

Only one of the physicians who were surveyed possessed a radiation survey meter. Two others provided personnel monitoring devices (film badges) for themselves and their employees. Few physicians surveyed had any idea of the radiation levels to which they and their employees were being exposed.

Radium Source Data

The number and activity of the various types of radium sources possessed by the physicians and the medical specialty of each physician are shown in table 6. A total of 164 sources possessed by private medical practitioners were surveyed. Of the radium possessed by private physicians, 530 milligrams (33 percent) were in the form of regular needles, 81 milligrams (5 percent) in the form of low-content needles, 500 milligrams (32 percent) in the form of tubes, 175 milligrams (11 percent in the form of plaques, and 300

Table 6. Radium source data

Facility number	Medical specialty	Age of sources (years)	Number and activity (in milligrams) of radium sources														Type of radium ownership
			Regular needles		Low-content needles		Tubes		Cells		Plaques		Nasopharyngeal applicators		Total		
			No.	Act.	No.	Act.	No.	Act.	No.	Act.	No.	Act.	No.	Act.	No.	Act.	
1	Surgery	28	6	50											6	50	Leased
2	Radiology	1	15	100											15	100	Leased
3	E,E,N,& T	24											1	50	1	50	Owned
4	Surgery	18	5	50											5	50	Owned
5	Surgery	25	6	30			3	100			1	10			10	140	Owned
6	E,E,N,& T	10											1	50	1	50	Leased
7	Surgery	10+									5	40			5	40	Owned
8	E,E,N,& T	7											1	50	1	50	Leased
9	Surgery	24-44			17	43	2	50			1	5			20	98	Owned
10	E,E,N,& T	19											1	50	1	50	Owned
11	Dermatology	14									1	10			1	10	Owned
12	Surgery	20	7	50											7	50	Leased
13	Surgery	19	5	25			3	75							8	100	Leased
14	Surgery	15	5	25			4	100							9	125	Leased
15	Dermatology	19	14	100											14	100	Owned
16	Surgery	15-35	5	25			9	175							14	200	Owned & Leased
17	Gen. Pract.	40	4	25											4	25	Owned
18	Surgery	10-42	7	50	23	38					1	10			31	98	
19	E,E,N,& T	18									1	50			1	50	Owned
20	Surgery	20+									1	5			1	5	Owned
21	E,E,N,& T	35											1	50	1	50	Owned
22	E,E,N,& T	12											1	50	1	50	Owned
23	Dermatology	6									1	5			1	5	Owned
24	Dermatology	39-49									5	30			5	30	Owned
25	Dermatology	24									1	10			1	10	Owned
TOTAL			79	530	40	81	21	500	0	0	18	175	6	300	164	1,586	

milligrams (19 percent) in the form of nasopharyngeal applicators, making a total of 1,586 milligrams of activity.

Table 6 also indicates the age of the sources used in private medical practice. Only the minimum age could be determined in the case of leased sources and certain other sources purchased directly from other physicians. The number of physicians owning or leasing radium is shown in table 6. When problems of source leakage were encountered, it was much easier to correct the situation if the physician leased his radium. If he owned the radium it was much more difficult. Many physicians who own radium have lost or misplaced their source purity certificates. It is also expensive to reencapsulate or exchange radium sources, and most physicians hesitate to bear such expense.

The number of radium sources in each age range and the number of physicians with sources in each age range are shown in table 7. Excluding sources of unknown age, there were 126 radium sources (88 percent) over 10 years of age and 60 (42 percent) over 20 years of age. The average age was 19 years, excluding sources of unknown age.

Table 7. Radium source age distribution

Minimum radium source age (years)	Number of sources	Physicians possessing radium
Unknown[a]	20	3
Less than 10	18	4
10 to 20	66	11
20 to 30	42	7
30 to 40	11	4
Greater than 40	7	3

[a]All sources of unknown age were known to have been more than 10 years old.

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Radium Source Security and Accountability

Radium facilities meeting at least one of the following conditions were judged by the surveyors to not require the assignment of a source custodian and the keeping of records for the issuance and receipt of radium sources:

1. Only one physician uses the radium and he removes and returns it to storage.

2. The patient is treated only in the office.

Using these criteria, 18 facilities (72 percent) were judged not to require a source custodian and the keeping of source use records. Of the remaining 7, only 2 assigned an official source custodian and kept proper source records; however, the user was always advised of the desirability of maintaining source usage records.

In addition to the need for adequate accountability procedures, radium sources should be protected from unauthorized removal. Of the private physicians surveyed, 11 did not provide a lock on their radium storage container and/or storage room door.

Radium Storage Data

Only one facility had more than one radium storage location. The radium storage area of each facility was also used for purposes other than radium storage. The radium was either stored in a general storage closet, in an office, in a treatment and examination room, or in an x-ray room. In one instance, a basement area was used for storage.

Only one physician had placed a radiation or radium warning sign on the storage room door, while only two placed such signs on their radium storage container. None had posted any type of emergency instructions related to their radium. Lack of warning signs was usually corrected by the surveyors on the spot. In a few cases the physician balked at having a warning sign posted and claimed it would frighten his employees.

The storage containers used can be broken down into four basic types. Each type and number of physicians using a specific type is given in table 8. Most of the physicians kept their radium in the lead container in which it was originally shipped to them by the radium supplier.

Table 8. Radium storage container types

Storage container type	Number
Special radium safe.	2
Small lead container	17
Lead container in commercial office safe	5
Commercial office safe only.	1

The average total lead equivalent shielding of the radium storage containers was 1.48 inches based on 23 facilities. Table 9 is an attempt to demonstrate effectiveness of the attenuation provided by the storage containers surveyed. It shows the distribution of the distances from the center of the storage container to the 2.5 mR/hour isodose line.

Table 9. Radium storage container effectiveness

Distance from center of storage container to 2.5 mR/hr isodose line (feet)	Percent of facilities (percent)
Less than 2.	17
2 to 4	35
4 to 6	13
6 to 8	13
8 to 12.	22

Radium Source Preparation

Extensive source preparation (loading and unloading applicators, and so forth) was required in only nine of the 25 facilities surveyed. Of these nine, only two had lead

L-blocks or other shielding devices. The handling equipment used ranged from short tweezers to lead vises. Table 10 shows the number of physicians with adequate handling equipment, inadequate handling equipment, and handling equipment of questionable adequacy. Judgments as to equipment adequacy are simply value judgments of the surveyors.

Table 10. Radium handling equipment adequacy

Equipment adequacy	Number of facilities
Adequate	14
Questionable	4
Inadequate	5
Not completely determined	2

Source Transport Devices

Table 11 shows the use of radium transport devices. Although no attempt was made to determine the radiation exposure of personnel while transporting radium sources, the contact surface dose rate of the transport devices used ranged from hundreds of milliroentgens per hour to several roentgens per hour.

Table 11. Radium transport devices

Type	Number of Facilities
Hand carrier	2
Transport cart	2
Storage container	10
Other	1
Not required	10

Source Sterilization

Radium source sterilization methods employed by radium users were investigated (table 12). Heat sterilization methods were used by only three physicians. Most physicians cold sterilized their radium and radium applicators with zephiran solution, or else they did not sterilize the sources at all.

Table 12. Radium source sterilization methods

Sterilization technique	Number of physicians using method
Cold (zephiran, alcohol, etc.)	13
Heat (autoclave)	[a]3
Sources never sterilized	10
Unknown	1

[a]Two of these sterilize loaded radium applicators with heat, but cold sterilize individual radium sources.

Area Radiation Survey Data

Alpha contamination measurements were made in and around the radium storage area (table 13). For purposes of comparison, the areas in which alpha contamination measurements were made are broken down into seven categories. Only the maximum reading obtained in each location category has been recorded. The maximum radium source leakage found at each radium facility is given in order to compare source leakage with alpha contamination.

Table 14 summarizes the leakage versus contamination data. Leakage was found in some instances in which contamination was not found. The reverse of this was sometimes true. Contamination was found in all cases of source leakage above 250 counts per minute alpha on the leak test jar lid, and source leakage wad detected in all cases of contamina-

Table 13. Alpha contamination

Facility number	Maximum alpha contamination (in counts per minute) found[a]							Maximum source leakage found
	Radium storage container	Floor	L-Block	Handling equipment	Applicators	Transport devices	General	
1	500	0	--	0	0	(b)	--	0
2	(c)	0	1,000	0	0	0	--	>100,000
3	>100,000	10,000	--	--	--	--	--	>100,000
4	250	0	--	--	--	(b)	--	0
5	30,000	0	--	--	--	30,000 to 40,000	--	100,000
6	0	0	--	0	--	0	--	0
7	30,000	0	--	--	--	--	--	>100,000
8	0	0	--	1,000	--	--	--	0
9	30,000	0	--	--	--	(b)	--	>100,000
10	0	0	--	--	--	0	--	0
11	0	0	--	0	--	0	--	250
12	>100,000	0	--	100,000	100,000	(b)	--	(d)
13	30,000	0	--	0	750	0	--	750
14	250	0	--	0	0	(b)	--	0
15	50,000	0	--	0	--	--	--	>100,000
16	1,000	0	--	--	--	0	--	0
17	0	0	--	0	0	0	--	250
18	(e)							>100,000
19	50	0	--	0	--	--	--	0
20	5,000	0	--	0	--	(b)	--	250
21	0	0	--	0	--	--	--	0
22	15,000	2,000 to 3,000	--	--	--	--	2,000 to 3,000	>100,000
23	0	0	--	0	--	0	--	0
24	>100,000	0	--	--	--	(b)	--	>100,000
25	>100,000	0	--	--	--	(b)	--	>100,000

[a]Measured with an Eberline PAC 3G.

[b]See table 15.

[c]Not fully checked.

[d]Ruptured source.

[e]Not determined.

tion above 1,000 counts per minute alpha. The data indicated that contamination readings greater than 1,000 counts per minute are indicative of significant source leakage (assuming 1,000 counts per minute on the leak test jar lid to be significant), but source leakage below this amount is not always indicated by the evidence of measurable contamination.

Table 14. Facility contamination versus source leakage

Contamination survey results	Number of facilities	Leaking sources (percent)
Found	19	68
Not found	6	33

Gamma dose rate measurements were also obtained in and around the radium storage area. Measurements were made on the surface of the storage container and at or near occupied areas. If a wall separated the storage room from an occupied room, the highest dose rate on the surface of the near wall was also obtained.

Table 15 presents the results of an evaluation of personnel radiation exposure during the time in which the radium sources were in their normal storage location. It should be stressed that this is only an attempt to estimate radiation exposure using the gamma dose rate measurements and occupancy factor estimates made at each facility. No attempt has been made to estimate the radiation exposure of individuals while actually handling and using radium.

In making exposure estimates, it was assumed that a physician spent 40 hours a week in his private practice and that one-half of this time was spent at his desk. It was also assumed that the remainder of his time was equally

divided between his examination and treatment rooms. Secretaries or clerks were assumed to spend 100 percent of their time at their desks. Assistant medical personnel (nurses, and so forth) were assumed to divide their time equally between the physician's examination and treatment rooms and whatever clerical duties were assigned. The exposure level in a room was taken as the exposure calculated if they had not been specifically measured.

Table 15. Gamma radiation exposure

Facility number	Source shielding (inches-lead)	Source to 2.5 mR/hr isodose line	2.0 mR/hr in uncontrolled area	Number of occupational exposures of 25 to 99 mR/wk	Number of occupational exposures of >100 mR/wk
1	0.75	7.0		1 (32 mR/wk)	
2	3.00	4.0			
3	1.75	3.8			
4	0.50	8.5	yes	1 (36 mR/wk)	1 (160 mR/wk)
5	0.50-1.25	8.5	yes	1 (60 mR/wk)	1 (140 mR/wk)
6	2.00	3.2			
7	0.33	8.7			
8	2.00	3.2		1 (55 mR/wk)	
9	0.50-0.75	10.0-12.0		3 (40 mR/wk) 1 (50 mR/wk)	1 (180 mR/wk)
10	3.00	1.8			
11	1.00	2.7			
12	2.00	3.2			
13	1.50	6.3	yes	1 (40 mR/wk)	1 (120 mR/wk)
14	2.00	5.2			1 (100 mR/wk)
15	0.50	12.0	yes		2 (190 mR/wk)
16	2.00	6.5	yes		1 (180 mR/wk)
17	0.75	5.1			
18	(a)				
19	2.50	2.3	yes		
20	1.00	1.8			
21	3.00	1.8			
22	(a)				
23	1.00	1.8			
24	0.75	5.6			
25	1.00	2.7			
TOTALS		Facilities	6 (26%)	6 (26%)	7 (30%)
		Individuals[b]	--	10 (11%)	8 (9%)

[a]Incomplete information.

[b]There was a total of approximately 90 occupationally exposed individuals in the private offices surveyed.

Also included in table 15 is an estimate of the number of facilities in which the 2.0 mR/hour isodose line extends beyond the confines of the user's control. This information has been included in order to show the number of facilities that would be in noncompliance with AEC regulations regarding permissible external exposure levels outside of restricted areas if, rather than radium, the radioactive material were an AEC licensed radioisotope.

Table 15 shows a positive correlation between the probability of an overexposure occurring in an installation and the distance from the installation's radium supply to the 2.5 mR/hour isodose line. An exposure rate of 2.5 mR/hour was chosen for comparison since it is the exposure rate that would result in an exposure of 5 R per year, if a person were continuously exposed to it for 40 hours a week.

Radium Source Leakage Data

The results of radium source leak testing are shown in table 16. While 68 percent of the sources individually leak tested had no detectable leakage, 18 percent had leakage rates of more than 100,000 counts per minute on the leak test jar lid. If plaques are excluded from the data, 8 percent of the remaining sources show leakage of more than 100,000 counts per minute on the leak test jar lid. There is essentially no change in the data at leakage rates below 100,000 if plaques are excluded.

No detectable source leakage was found in 40 percent of the facilities, while 40 percent had sources with leakage of more than 100,000 counts per minute on the leak test jar lid. Although 8 percent of the sources individually leak tested gave jar lid count rates of between 1,000 and 100,000 counts per minute, there were no facilities with maximum source leakage in this range. A possible explanation for this might be that sources displaying apparent source leakage in the range of 1,000 to 100,000 counts per minute on the leak

test jar lid were actually surface contaminated with radium resulting from contact with at least one actual leaking source.

Table 16. Radium source leakage[a]

Source leakage range (cpm alpha)	Number of sources	Percent of sources
Less than 100	87	68
100 to 1,000	8	6
1,000 to 10,000	8	6
10,000 to 100,000	2	2
Greater than 100,000	23	18

[a]Thirty-six sources that could not be individually leak tested are excluded.

If plaques are excluded from the data, then 33 percent of the facilities had maximum source leakage of more than 100,000 counts per minute on the leak test jar lid.

The age distribution of sources with apparent leakage is shown in figure 2. The tendency of older sources to leak more frequently is clearly demonstrated. Figure 2 may show the effect of source aging on leakage probability, or it may show a progressive improvement in source encapsulation techniques.

Table 17 compares the various types of sources with respect to their tendency to leak. Low-intensity needles, high-intensity needles, and tubes tended to leak with equal frequency. Plaques leaked more frequently than any other type of source, with 78 percent leaking grossly. Of the two nasopharyngeal applicators found leaking, one had been subjected to unusual stresses. A handle had been welded or soldered to the source; therefore the applicator may have been damaged.

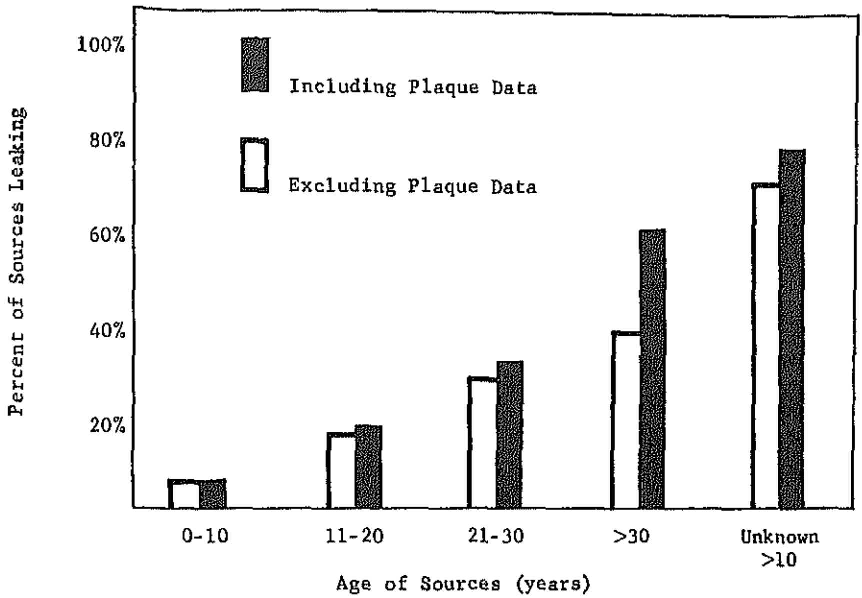


Figure 2. Leakage versus source age

Table 17. Radium source leakage versus source type

Type of radium source	Sources leaking greater than 100 cpm		Sources leaking greater than 100,000 cpm	
	Number	Percent	Number	Percent
Low-intensity needles	6	30	2	10
High-intensity needles	11	17	4	6
Tubes	6	29	1	5
Plaques	16	89	14	78
Nasopharyngeal applicators	2	33	2	33

[a]Sources for which individual leakage rates were not determined because of group leak testing have not been counted in determinations of percentage leakage.

The probability of a source developing a leak may increase with the total usage of the source, since use would subject it to stresses and hazards.

To test this hypothesis, the number of sources leaking at each facility was compared with the radium treatment frequency and the estimated total number of times a source had been used. The total number of times a source had been used was roughly estimated by assuming the stated treatment frequency never varied, dividing this treatment frequency by the number of sources, and multiplying by the number of years the sources had been in use. No apparent correlation between leakage and source usage was seen using this method.

Supplemental Studies

RADIATION EXPOSURE OF RADIUM SURVEY PERSONNEL

As Phase II developed, it became apparent that the radiation exposure of the project surveyors should be thoroughly evaluated. Their health and safety were of concern, and from a research standpoint the opportunity was available to determine the radiation levels to which radium survey personnel would be exposed.

Three dosimetry methods were used: film badges, pocket dosimeters, and thermoluminescent dosimeters (TLD). Unfortunately, the use of these dosimetry techniques was not initiated simultaneously.

Film Badge

Throughout the course of Phase II, film badges were worn by survey personnel. One surveyor wore two badges (two different film badge companies) and the other wore only one badge. The accuracy of the badges worn was tested on two separate occasions by exposing badges to known exposures using a radium source. Film badge results were found to be

within ±20 percent of the true exposure for two of the three film badges used.

Table 18 gives the monthly film badge results for the two surveyors. This table also shows the total amount of radium to which each surveyor was exposed. If sources were first group leak tested and then individually leak tested when leakage was indicated, then the amount of radium individually leak tested was added to the facility's total radium supply to determine the total amount of radium handled by the surveyors at that facility.

Table 18. Trunk exposure data for radium surveyors during 1965

Exposure period (month)	Surveyor A			Surveyor B		
	Radium handled (mg)	Film badge reading (mR)	Pocket dosimeter reading (mR)	Radium handled (mg)	Film badge reading (mR)	Pocket dosimeter reading (mR)
1	69	<20	--	69	<20	--
2	200	70	--	150	20	--
3	490	60	--	490	50	--
4	105	<20	--	105	<20	--
5	125	20	--	125	<20	--
6	325	120	--	190	<20	--
7	290	90	[a]>43	290	20	25
8	445	130	[a]>97	445	70	79
9	0	30	0	375	50	83
10	10	20	0	10	30	0

[a]Pocket chambers were not worn during all surveys performed.

Pocket Dosimeter

During the latter part of July, it was decided that it would be desirable to use pocket dosimeters in order to complement the film badge and TLD data. Thereafter, each surveyor wore two pocket dosimeters in his breast pocket.

Dosimeter reliability and accuracy were determined by checking each chamber for drift over a period of several

days, then exposing the chambers to a series of known radium exposures. Drift was determined to be less than 10 mR for a period of several days and radium exposures were correct to within ±10 percent in the exposure range used (25 to 150 mR). Upon entry to and exit from a facility to be surveyed, the reading of the pocket dosimeter was recorded and the difference obtained. Dosimeter drift was probably insignificant.

Table 18 also includes a tabulation of the pocket dosimeter readings for both surveyors. The readings recorded in table 18 are the average of the readings obtained from the two pocket dosimeters worn.

Considering that pocket dosimeters and film badges were not worn on the same position on the body, the agreement between them was very good. These results indicate that a radium survey team using these survey methods should be able to survey up to 1,000 milligrams of radium a month without exceeding an exposure to the trunk of 5 R per year.

Thermoluminescent Dosimeter

During June 1965, the use of lithium fluoride (LiF) thermoluminescent dosimeters (TLD) was initiated. These dosimeters were supplied and read out by the X-Ray Exposure Control Laboratory, National Center for Radiological Health, Public Health Service. Each dosimeter consisted of 30 milligrams of type TLD-100 (Harshaw Chemical Company) LiF powder contained in a teflon capsule.

These dosimeters have an extremely wide range (10^{-2} to 10^{5} R), are dose rate, energy, and angular independent, show little or no fading over extended periods of time, and are very small in size. They are ideal for personnel dosimetry of individuals exposed to radium, since both hand and finger exposures can be readily measured as well as trunk exposures.

The dosimeters used on fingers were taped to the tip of the fingers of rubber gloves so that they were at the very tip of the finger when the gloves were worn by the surveyors

during leak testing. The palm dosimeters, when worn, were taped directly to the palm of each hand. The dosimeter worn at the waist was taped to an empty film badge holder.

The surveyors, who were both right-handed, alternated in handling the radium during leak testing. If one surveyor loaded leak test jars in one facility, the other surveyor unloaded the leak test jars. The TLD's were worn only by the person who was handling the radium during leak testing; therefore, the dose recorded by these dosimeters was the total dose received during leak testing. This total dose was divided between the two surveyors.

TLD's were worn during a period in which five facilities were surveyed, returned to the X-Ray Exposure Control Laboratory for readout, and then worn again during the survey of three radium facilities.

The leak test beginning and ending times were recorded for each facility surveyed, as well as for the loading of each leak test jar. Table 19 gives the elapsed time, number of sources, number of leak test jars and total activity of leak tested sources during the first and second TLD use period.

Table 19. Thermoluminiscent dosimetry (TLD) use data

TLD use period	Surveys completed	Total radium surveyed (mg)	Sources surveyed	Total exposure time[a] (min.)	Leak test jars used
First	5	475	57	89 +	43
Second	3	445	50	48	42
Total	8	920	107	137 +	85

[a]Period of time during which TLD's were actually worn by survey personnel.

Table 20 shows the TLD exposure readings for both use periods. In order to assess the accuracy of this data, a

detailed analysis of the leak test procedures was made, and, using this analysis, the expected exposure to the right thumb during the second TLD wearing period was calculated. There was close agreement between the calculated dose and the TLD measured dose.

Table 20. TLD exposure data

Position monitored	Exposure (mR) First period	Exposure (mR) Second period
Right thumb	3,719	744
Right middle finger	1,898	672
Right little finger	1,587	476
Right palm[a]	--	369
Left thumb	948	302
Left middle finger	920	271
Left little finger	976	226
Left palm[a]	--	150
Forehead	232	116
Waist	187	51

[a]Dosimeters were not worn on palms during first use period.

The calculations indicate that almost 70 percent of the dose received by the right thumb is due to screwing the jar lid on and off, since the source-to-finger distance is very short during this operation. The reduced dose to the middle and little finger can be readily attributed to the greater distance between these fingers and the source during the screw on-off operation.

The consistently lower exposure of the left hand is because it was usually further from the sources, and was used primarily for holding the leak test jars with rubber covered beaker tongs.

A detailed comparison between TLD, pocket dosimeter, and film badge data for whole-body exposure is beyond the

scope of this report; however, it can be shown that there is a good agreement between the data.

The ratio of the occupational RPG for the trunk (5 rems per year) to the occupational RPG for the hand (75 rems per year) is 1:15. The use of TLD's has shown that the hand and finger exposures of radium surveyors performing leak tests using the jar method may result in hand to trunk exposure ratios greater than 15:1; thus, hand and finger radiation exposure should be monitored at the point of highest expected exposure.

STUDY OF RADIUM CONTAMINATION INSURANCE

The need to learn more about radium contamination insurance prompted the Radiological Health Service of the Georgia Department of Public Health to contact the home office of major casualty companies in order to obtain authoritative answers to basic questions about such insurance. The following were the findings:

1. Professional liability insurance policies will not provide first and second party coverage in the event of radioactive contamination occurrence. Such policies provide protection only against third party claims.

2. An endorsement or rider can be attached to a fire insurance policy which provides first party coverage for radioactive contamination caused by radioactive materials used or kept on the premises of the insured. This coverage may be limited or broad. The limited form insures against direct loss caused by sudden and accidental radioactive contamination because of perils named in the endorsement. Broad coverage insures against direct loss by sudden and accidental radioactive contamination, regardless of the peril. This would, of course, mean a slight increase in insurance rates. There are many factors that will determine the increase, but it might be expected to be between 0.5 and 5 cents

per $100 of fire insurance coverage.

3. The nuclear exclusion clause attached to liability policies does not apply to naturally occurring or accelerator-produced radioisotopes, nor to byproduct material.

CONCLUSIONS

The following are the basic conclusions of Phase II, Georgia Radium Management Project:

1. Radium and other radiation sources can be easily and quickly located in a State by means of an inventory procedure utilizing a brief, post card size form.

2. Using the proper approach, radium used in private medical offices can be surveyed without legal inspection requirements. A two-man survey team can make a survey quickly and effectively.

3. Radium is used more frequently by physicians in private offices than it is in hospitals, although the number of private medical users seems to be declining.

4. The dermatological use of radium still seems to be prevalent in private medical offices and is not confined to dermatologists.

5. In general, the knowledge and practice of radiation safety is inadequate among private medical users. A significant number of overexposures is probable.

6. Approximately 40 percent of the surveyed medical radium facilities had radium sources in their inventories that leaked significantly. Twenty to 30 percent of all surveyed radium sources were leaking significantly. The older the radium source the greater the probability that it will leak. No relation seems to exist between source usage and source leakage. Radium needles and tubes tend to leak with equal frequency; however, radium plaques show a greater leakage frequency. If plaques are excluded from the data, then 10 to 20 percent of the radium sources were leaking.

7. Although the presence of contamination was not always indicative of source leakage, significant contamination (greater than 1,000 counts per minute alpha) was always associated with source leakage. The data is too limited to form general conclusions concerning the use of contamination measurements to indicate significant source leakage.

8. There was a complete lack of knowledge concerning the existence of and need for radioactive contamination insurance. Contamination insurance in the form of a rider on a fire insurance policy would cost between 0.5 and 5 cents per $100 of fire insurance coverage.

9. Personnel monitoring data indicates that radium surveyors using survey methods employed during Phase II should be able to survey up to 1,000 milligrams of radium per month without exceeding a trunk exposure of 5 rems per year; however, hand and finger exposures should be carefully monitored to prevent overexposures. LiF thermoluminescent dosimeters seem to be ideal for such monitoring.

Summary

The Georgia Radium Management Project was a cooperative study involving the Radiological Health Service of the Georgia Department of Public Health and the U.S. Public Health Service, National Center for Radiological Health. The objectives of the Project were to: develop and test procedures and techniques for the survey of medically used radium and to assess the radiological health aspects of the use of radium in medical practice. Phase I of the Project, directed toward the use of radium in hospitals within the State of Georgia, began in October 1963 and was completed in December 1964. Phase II, which began in January 1965 and was completed in October 1965, was directed toward the use of radium in private medical offices and clinics.

Phase I

A questionnaire was mailed to the 210 licensed hospitals in Georgia. A total of 24 hospitals owned or leased radium and an additional 40 allowed it to be used within the hospital.

A checklist form was used for the survey. A simple radium leak test method suitable for field use was also devised.

An explanation of the Project was given to the hsopital administration and person responsible for the radium at each hospital surveyed. Background information was obtained and external gamma radiation and alpha contamination levels in and around the storage area were monitored. Techniques, procedures and equipment associated with the use, handling, and storage of radium were observed and recorded. Radium sources were then leak tested, using the "jar" method. A verbal and written report on the survey findings was made to the responsible person and to the hospital administrator.

Radium treatment frequency was independent of hospital size and ranged from 1 to 100 treatments per year with a total of 898 treatments per year for the 24 hospitals surveyed. Radium inventories ranged from 50 to 440 milligrams. There were 787 sources containing 3,725 milligrams of radium.

Forty-six percent of the hospitals had leaking or contaminated sources. Five hospitals routinely leak test their radium. Four hospitals were grossly contaminated, eight were not contaminated, while 12 had contamination either less than 2,000 counts per minute per 100 cm^2, or contamination above this level but confined to one or two small spots in the storage area.

Inadequate radium storage resulted in excessive exposure levels in 33 percent of the hospitals. The highest exposure observed was estimated to be 1 or 2 roentgens per week.

PHASE II

Prior to the initiation of the Phase II field surveys, a post card size radium inventory form was mailed to the State's 2,832 licensed physicians. Thirty-two of the respondents actually owned or leased radium.

A nine-part radium survey form used in conjunction with a checklist was selected for use during the Project. The survey was performed by a two-man survey team after arranging the survey appointment by telephone. A comprehensive report to the file in narrative form was written, as well as a followup letter to the physician which summarized the findings of the survey and outlined recommendations for correction of the major deficiencies found.

Twenty-five private medical offices and clinics were surveyed. Awareness of radium hazards and radiation safety principles and techniques by the physicians was found to be quite limited.

One hundred and sixty-four radium sources, with a total activity of 1,586 milligrams, were possessed by the study group. The average age of these sources was 19 years, excluding sources of undetermined age, while 42 percent were more than 20 years old.

A total of 2,100 radium treatments per year were being given by the physicians surveyed. Eighteen physicians gave a total of approximately 1,300 dermatological treatments per year, although only five of these physicians were dermatologists.

Ten physicians used their radium at one or more local hospitals as well as their own office. Usually, there was no special policy of isolating hospitalized patients during treatment with radium. Isolation of the patient in the physician's office was the exception rather than the rule.

The use of film badges and radiation survey meters was almost totally lacking, yet it was estimated that 9 percent of the exposed or potentially exposed occupational personnel received exposures in excess of 100 mR per week. At least one person was exposed in excess of 100 mR per week in 7 of the 23 facilities in which an adequate evaluation had been made.

The storage of radium was generally inadequate, as witnessed by the excessive exposure levels encountered.

Alpha contamination was found in 19 facilities. Only 68 percent of these facilities had leaking sources, while slight leakage was found in 33 percent of the uncontaminated facilities.

Of the sources individually leak tested, 32 percent showed leakage of more than 100 counts per minute on the leak test jar lid, and 10 percent showed more than 100,000 counts per minute. Fifteen facilities possessed sources which showed leakage of more than 100 counts per minute on the jar lid, and ten possessed sources which showed leakage of more than 100,000 counts per minute. A positive correla-

tion was seen between source leakage and source age.

A detailed evaluation was made of the radiation exposure received by personnel who performed the radium field surveys. Film badges, pocket dosimeters, and lithium fluoride thermoluminescent dosimeters were used. The results indicated that up to 1,000 milligrams of radium a month could be surveyed without exceeding exposure limits to the trunk. However, hand exposures should be monitored to assure that hand exposure limits are not exceeded.

A study was made of radioactive contamination insurance. None of the physicians carried such insurance nor were they aware that insurance was available. It was determined that many insurance companies provide this insurance in the form of a rider or endorsement on fire insurance policies.

REFERENCES

(1) BENSON, J. and R. FETZ. A technique in testing radium sources for leakage. Am J Roentgenol Radium Therapy Nucl Med 99:479-481 (February 1967).

(2) FETZ, R. and R. AUGUSTINE. Management of a radium incident at Americus and Sumter County Hospital (abstract). Health Phys 11:827 (August 1965).

ATTACHMENT A

State of Georgia
Department of Public Health
JOHN H. VENABLE M.D. DIRECTOR 47 TRINITY AVE ATLANTA GEORGIA 30334

January 18, 1965

Dear Doctor:

The Georgia Department of Public Health is presently attempting to locate all sources of ionizing radiation within the State. In order to obtain this information, we are enclosing a self-addressed, prepaid post card for your convenience.

In addition to completing the form, would you please fill in your present address on the front of the post card so that we may bring our current mailing list up to date.

We would like to emphasize, that even though you may not have radiation sources, that you so indicate on the enclosed card and return it at your earliest convenience.

Your cooperation in furnishing this information is very much appreciated.

Sincerely yours,

Richard H. Fetz

Richard H. Fetz, Chief
Radiological Health Section

RHF/ah
Enclosure

ATTACHMENT B

GEORGIA RADIATION SOURCE INVENTORY CARD

GEORGIA RADIATION SOURCE INVENTORY

X-RAY PRODUCING EQUIPMENT	YES	NO
1. Do you own or lease X-ray producing equipment? (Include any Fluoroscope).............	☐	☐
Number of Machines ______		
RADIUM		
2. Do you use, own, lease or store radium?...........	☐	☐
Use ___ Own ___ Lease ___ Store ___ Other ______		
3. Have you ever owned, leased or stored radium?......	☐	☐
OTHER RADIOACTIVE MATERIAL		
4. Do you use, own, lease, or store radioactive material other than radium?......................	☐	☐

OFFICE ADDRESS:

______ Street ______ Signature

______ City ______ Office Phone ______ Inventory Code #

Back

______
______
______
Return Address

THIS SIDE OF CARD IS FOR ADDRESS

Radiological Health Section
Georgia Department of Public Health
47 Trinity Avenue, S. W.
Atlanta, Georgia 30334

Front

ATTACHMENT C

State of Georgia
Department of Public Health
JOHN H VENABLE M D DIRECTOR 47 TRINITY AVE ATLANTA GEORGIA 30334

February 15, 1965

Dear Doctor:

On January 18, 1965 the Georgia Department of Public Health, in an attempt to locate all sources of ionizing radiation, mailed to each private physician within the State a simple post card questionnaire. As of this date, we have not received a reply from your office. In order to obtain this information, we are enclosing another self-addressed post card for your convenience.

In addition to completing the form, would you please fill in your present address on the front of the post card so that we may bring our current mailing list up to date.

We would like to emphasize, that even though you may not have radiation sources, that you so indicate on the enclosed card and return it at your earliest convenience.

Your cooperation in furnishing this information is very much appreciated.

Sincerely yours,

Richard H. Fetz

Richard H. Fetz, Chief
Radiological Health Section

RHF/ah

Enclosure

ATTACHMENT D

Georgia Department of Public Health
RADIUM SURVEY FORM

I. General

Date: MAY 4-5, 1965
Surveyors: POSEY, ROBINSON
Date Last Survey: NONE

A. Facility DR.

Address GA.

Administrator:

B. Owners / Lessee

C. Person Directing Radium Use

Name: DR

Title:

D. Years radium used: 20 YEARS

Frequency 52 / YEAR

E. Person(s) interviewed

Name: DR.

Title:

F. Person(s) using radium

DR.

G. 1. Type and size of facility: PRIVATE CLINIC -

2. User Experience: —

3. Types of Treatments: SKIN LESIONS - NEEDLES PUT IN TUBE AND THIS TAPED DIRECTLY TO SKIN

4. AEC Licenses: NONE

5. Radium Substitutes: No

6. Insurance: — PROFESSIONAL LIABILITY

7. Other Institutions: No

NOTE: ONE (1) 7.5 mg NEEDLE LOANED TO DOCTOR IN IN 1955 OR 1956. WHEN NEEDLES RETURNED ONE (1) WAS MISSING. GA. DEPT OF PUBLIC HEALTH. CALLED IN AND SEARCH FAILED TO TURN-UP NEEDLE. ONE NEEDLE WAS ALSO FLUSHED DOWN TOILET AND RECOVERED AND PRESENTLY BEING USED.

Georgia Department of Public Health
RADIUM SURVEY CHECK LIST

II. Radiation Safety

____1. Radiation Safety During Treatment

___a. Patient isolation-tagging

___b. Attendants instructed

___c. Attendants monitored

___d. Source removal

___(1) Who removes ___(2) Removal instructions

___(3) Storage return ___(4) Intermediate storage

____2. Radium Department Personnel Instructions

___a. Oral ___b. Written ___c. Other

____3. Radiation Instruments

___a. Type ___b. Functioning ___c. Calibrated

____4. Medical Examinations

___a. Type ___b. Frequency ___c. Results

____5. Radium Department Personnel Monitoring

___a. Type-Company ___b. Read frequency

___c. Who is monitored ___d. Results

III. Source Description

____1. Size ____5. Supplier

____2. Activity ____6. Pedigree

____3. Type ____7. Calibration

____4. Age ____8. Other Information

IV. Source Security

____1. Source custodian

____2. Source records

___a. Inventory ___b. Issue ___c. Receipt

____3. Locks and Keys

___a. What locked ___b. When locked ___c. Who has key

V. Source Storage

____1. Location

____2. Relation to Preparation Area

____3. Ventilation

____4. Posted Emergency Instructions

____5. Warning Signs

____6. Radium Vault

___a. Compartmented

___b. Labeling

___c. Like source segregation

___d. Size

___e. Make

___f. Attenuation

VI. Source Preparation and Transportation

____1. Preparation Area

___a. Location

___b. Shielding

____2. Handling Equipment

___a. Type

___b. Adequacy

____3. Lighting

____4. Transport Devices

___a. Type

___b. Capacity and loading

___c. Transport distance

___d. Taken out of facility

____5. Sterilization

___a. Method ___b. Where

Georgia Department of Public Health

II. Radiation Safety

1. ADEQUATE - PATIENT KEPT
a. IN EXAMINATION ROOM
b. FAIRLY WELL
c. No
d. NURSES AND DOCTOR
(1) NURSES AND DOCTOR
(2) NOT REALLY NECESSARY
(3) RETURNED TO STORAGE IMMED.
(4) NONE
2. NOT TOO MUCH
a. ORAL IF AT ALL
b. No
c. No

3. NONE
4. YES -
a. GENERAL MEDICAL EXAM
b. TWICE A YEAR - INCLUDING
c. BLOOD - NOTHING UNUSUAL NOTED
5. NONE a.
b.
c.
d.

III. Source Description

1. 2 - 7.5 mg needles
2. 2 - 5.0 mg needles

* RADIUM KEPT IN STORAGE BOX WITH LABEL MARKED STANDARD CHEMICAL COMPANY - DISTRIBUTED BY RADIUM CHEMICAL CO.

Age - Approximately 40 yrs old Given to Dr. [redacted] by father who also used same radium calibrated by NBS - twice

IV. Source Security

1. None
2. None
a.
b.
c.

3. No, radium KEPT IN OLD
a. X-RAY FILM CABINET
b. CONSTRUCTED OF THIN SHEET
c. METAL -
ONLY CLINIC LOCKED -

Georgia Department of Public Health

RADIUM SURVEY FORM

V. Source Storage

1. STORAGE CLOSET (OFFICE SUPPLIES) IN OLD X-RAY ROOM. USING FILM CABINET

2. NO PREPARATION AREA REQUIRED SINCE ALL RADIUM KEPT IN TUBE

3. NONE

4. NONE

5. NONE.

6. RADIUM KEPT IN SMALL
   a. WOODEN BOX WITH APPROX
   b. 3/4" OF LEAD PROTECTION
   c. ALL NEEDLES KEPT IN ONE
   d. TUBE SO NO LABELING
   e. OR SEGREGATION NEEDED.
   f.

VI. Source Preparation and Transportation

1. NONE
   a.
   b.

2. ONLY FORCEPS AND TAPE
   a.

   b.

3. ADEQUATE

4. NONE
   a. —
   b. —
   c. — d. —

5. NONE
   a. —
   b. —

VII. Area Survey:

a. Contamination - NONE FOUND ON X-RAY FILM CABINETS, DOOR TO CLOSET, FLOOR, PLASTIC BOX WHICH HOLDS STORAGE BOX AND STORAGE BOX.

I.D.	Meter G.F.	Meter Sc.	Meter G.C.	Readings Alpha	Readings Beta	Readings Gamma	Type Dir.	Type Wipe	Remarks
				EVERYTHING	CLEAN	OF	ALPHA		
				CONTAMINATION					

Code: I.D. - Identification Number (see IX) Sc. - Scintillation Alpha Meter
G.F. - Gas Flow Alpha Meter G.C. - Geiger Counter

Georgia Department of Public Health

B. Gamma Exposure Levels

	Meter		Reading			Meter		Reading	
I.D.	C.P.	G.C.	MR/HR	Remarks	I.D.	C.P.	G.C.	MR/HR	Remarks
1		✓	7	WAIST LEVEL					
2		✓	600	SURFACE OF LEAD BOX					
3		✓	110	1 FOOT FROM FILM BOX					
1		✓	5	DOOR CLOSED					
4		✓	18	AGAINST WALL					
5		✓	7	AGAINST MEDICINE CABINET					
6		✓	7	DOOR ENTRANCE DOOR OPEN					
7		✓	0 5	AT DESK IN EXAMINATION ROOM					

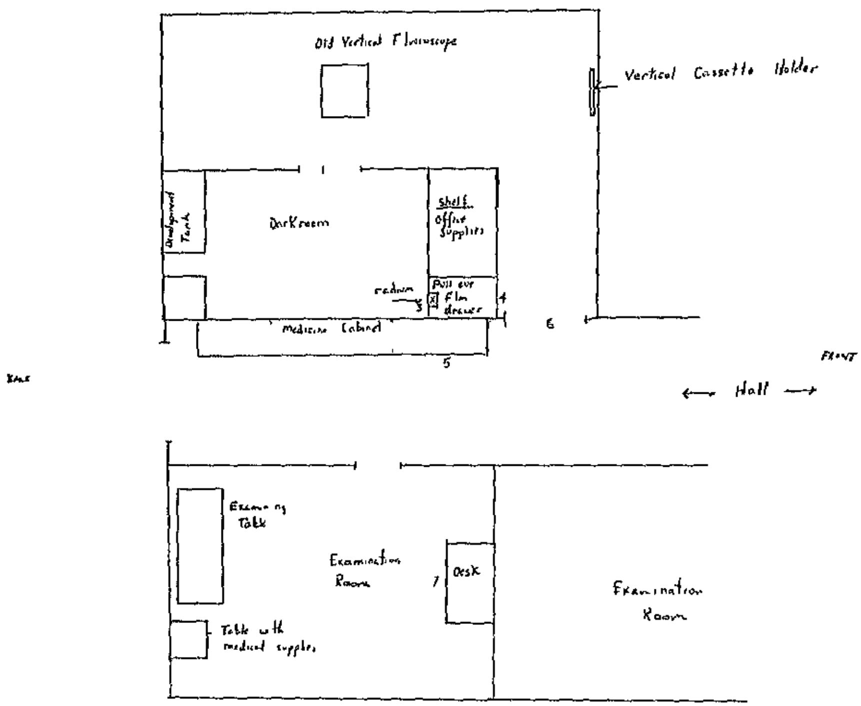
Code: I.D. - Identification Number (see IX); C.P. - Cutie Pie Survey Meter
G.C. - Geiger Counter

VIII. Leak Test Data:

		Time		Readings			
Jar No.	Contents	In	Out	Alpha	Beta	Gamma	Remarks
1	7.5 mg needle	8 30 5-4	10:30 5 5	0			
2	5.0 mg needle	3:30 5-4	10:30 5-5	0			
3	7.5 mg needle	3:30 5-4	10:30 5-5	250			
4	5.0 mg needle	3:30 5-4	10:30 5-5	0			

Georgia Department of Public Health

IX. Sketch: (Identify contamination and gamma readings, show radium storage and preparation area, approximate dimensions, doors, windows, adjacent areas, etc.)



2= surface of storage box

ATTACHMENT E

Georgia Department of Public Health
Radiological Health Section
47 Trinity Avenue
Atlanta, Georgia

RADIUM SURVEY REPORT
For
Dr.
Georgia

May 27, 1965

Radium Survey Report

Facility: Dr.

Address: Georgia

Survey Date: May 4-5, 1965

Surveyors: (1) Cecil D. Posey (2) Earl W. Robinson

Report Date: May 27, 1965

General: Dr. owns and operates a private general medicine type clinic. The radium at this facility was formerly the property of the father of Dr. When he died Dr. inherited the radium (approximately 20 years ago).

Dr. uses his radium sources (4 radium needles) for treatment of skin lesions. The treatments are accomplished by placing the needles in a brass capsule, where they are normally kept, and taping the capsule directly to the skin. His present treatment rate is approximately 50 per year. Normally each treatment lasts approximately one hour.

This physician possesses no other radioactive material, he carries only professional liability insurance and his radium is used only at his clinic.

Two radium loss incidents have occurred at this facility. Dr. reported that in 1955, the radium sources of this facility were loaned to another doctor who had a practice in The first time Dr. used the radium after its return, he noticed that one of the needles was missing. At that time he called the State Health Department and a representative was sent to search for the radium which could not be found.

The State Health Department representative who made this radium search was subsequently identified and questioned concerning this incident. He reported that he was told that the radium needle (10 mg) was lost

during treatment. He searched for the source throughout the clinic, the surrounding yard and the laundry which the clinic used without being able to locate the source (using a geiger counter).

On another occasion (date undetermined) a radium needle was accidentally flushed down a toilet and subsequently located in the sewer line.

Radiation Safety: Patients are treated in the examination room at the rear of the clinic. As has been pointed out treatments are given for only one hour. Either or one of his nurses removes the radium at the end of the treatment time. Patient attendants are not monitored for radiation exposure. After removal, the person who removes the sources returns them directly to storage.

Personnel are not given any specific oral or written instructions but they seem aware that radium is hazardous and that they should stay away from it.

There are no radiation instruments at this facility. Neither is a film badge service provided. However, a general medical examination is given each employee, which includes a blood count, twice per year. Dr. reported that nothing unusual has been noted in the blood picture of any employee.

Source Description: The following is a description of the radium sources of this facility:

Quantity	Activity	Type	Supplier	Age
2	7.5 mg	needles	Radium* Chemical	40 years
2	5.0 mg	needles	Radium* Chemical	40 years

*Note: No pedigree sheet or bill of sale was available but sources were assumed to have been sold by Radium Chemical Company since the lead storage box was sold by Radium Chemical. Dr. also was able to recall that the sources had been calibrated twice by NBS.

Source Security: There is no official source custodian at this facility nor are any official source records kept. The source loss history of the facility would seem to indicate that the appointment of a custodian and the keeping of records might be desirable.

There is no lock on the source storage room nor on the radium container. The only security offered against unauthorized removal is the locking of the clinic each night. It was not determined how many people have access to the keys of the clinic.

Source Storage: Radium storage is located in the x-ray film dark room which connects with the room containing the x-ray machine. The x-ray machine and dark room equipment is no longer used. There is no source preparation area since the sources are always kept in a brass capsule applicator.

The storage room has no seperate ventilation nor are there any radiation warning signs or posted emergency instructions.

The radium itself is kept in a small (3"x3"x3") wood covered lead box sold by Radium Chemcial Company. This box offers approximately 3/4" of lead shielding. The box, itself, is stored in a plastic box within the x-ray film storage drawer in the dark room.

Source Preparation and Transportation: There is essentially no preparation involved. The needles are kept in a brass capsule applicator and, using forceps, taped directly to the skin.

The lead storage box is used to carry the sources to the treatment room which is just across the hall way. The brass capsule is not sterilized after treatment.

Area Survey: The following are the results of the area survey made at this facility:

A. Contamination

The x-ray film drawer, small plastic box holding the wood covered lead storage box, the lead storage box and surrounding area were checked with a gas flow proportional alpha field survey meter (Eberline PAC-3G, Serial No. 1486) and found free of any alpha contamination.

B. Gamma Exposure Levels

Location	I.D.*	Reading (mr/hr)
1. Dark room door way - door open	1	7.0
2. Dark room door way - door closed	1	5.0
3. Surface of lead storage box	2	600.0
4. Against wall in x-ray	4	18.0
5. Against pharmaceutical supplies cabinet in corridor	5	7.0
6. X-ray room door way	6	7.0
7. At desk in examination room across from radium storage	7	0.5

*Note: See I.D. numbers on facility sketch attached to survey form.

In all probability no one will be over exposed by the radium in its present storage location and with its present shielding. However, exposure levels do seem slightly excessive and could be significantly reduced by the addition of a modest amount of lead shielding.

<u>Leak Test Data</u>: The radium needles were taken out of their brass capsule applicator and individually leak tested. The following are the results:

Jar Content	Jar Lid Reading (C/)
1 7.5 mg needle	0
1 7.5 mg needle	250
1 5.0 mg needle	0
1 5.0 mg needle	0

Before the surveyors departed, they informed Dr. that one of his 7.5 mg needles was leaking very slightly but that it did not represent a hazard at the present time.

ATTACHMENT F

State of Georgia
Department of Public Health
JOHN H. VENABLE, M. D., DIRECTOR 47 TRINITY AVE. ATLANTA GEORGIA 30334

May 10, 1965

CONFIDENTIAL REPORT

"Information obtained and opinions based upon these investigations shall be confidential records of the Board of Health and shall not be open for public inspection." Regulation adopted by State Board of Health on October 16, 1941."

Dr.
Georgia

Dear Doctor:

A radium safety survey was performed at your office on May 4-5, 1965, by members of the Radiological Health Section of the Georgia Department of Public Health.

From an ingestion and inhalation viewpoint, the biological hazards associated with radium usage and handling make it extremely important that sources used in industry and medicine be periodically surveyed for radon leakage. Equally vital is the necessity for monitoring for contamination in the areas in which radium is used. In addition, other important parameters such as the adequacy of storage of the sources must be determined. This report summarizes our findings in these areas.

TESTING METHODOLOGY

A brief description of the method used to leak test the radium sources in your facility follows: The source is placed in a gas-tight enclosure for a period of 24 hours during which time any radon gas produced by the radioactive decay of radium will diffuse throughoutthe enclosure. The enclosure lid is then removed and immediately surveyed with an alpha sensitive instrument (Eberline PAC-3G) for evidence of build-up of radon daughter activity. Such a procedure will determine if the source is leaking minute quantities of radon or if it is contaminated on the surface by radium.

RESULTS

1. No radon leakage was indicated from three of the four radium needles leak tested and the fourth was leaking only slightly.

2. No significant alpha contamination was found in the room used for X-ray or the storage closet used to store the radium.

3. The storage and handling equipment was found to be adequate for the immediate future.

RECOMMENDATIONS

1. A resurvey on an annual basis.

If you have any questions concerning the material in this report, do not hesitate to call us.

Thank you for your cooperation during the survey.

Yours truly,

Cecil D. Posey
Senior Radiation Safety Officer
Radiological Health Section

CDP/ah

ENVIRONMENTAL HEALTH SERIES

RADIOLOGICAL HEALTH

The following technical reports issued by the Bureau of Radiological Health are available through the Office of Public Information and Education, Bureau of Radiological Health, Public Health Service, U.S. Department of Health, Education, and Welfare, Rockville, Md. 20852.

PHS Pub. No.	Title
999-R-1	Factors Influencing Strontium-90 in Milk from Brainerd, Minn. Milkshed
999-R-2	Rapid Methods for Estimating Fission Product Concentrations in Milk
999-R-3	Studies of the Fate of Certain Radionuclides in Estuarine and Other Aquatic Environments
999-R-4	Mathematical Programming Models for Selection of Diets to Minimize Weighted Radionuclide Intake
999-R-5	Radionuclide Analysis of Gamma-Ray Spectra by Stepwise Multiple Regression
999-R-6	Farming Practices and Concentrations of Fission Products in Milk
999-RH-7	An Environmental Surveillance Laboratory for Radionuclide Analyses
999-RH-8	X-Ray Equipment Survey in Polk County, Florida - September 1961-August 1963
999-RH-9	An Emanation System for Determining Small Quantities of Radium-226
999-RH-10	Procedures for Determination of Stable Elements and Radionuclides in Environmental Samples
999-RH-11	Radiochemical Determination of Uranium in Environmental Media by Electrodeposition
999-RH-12	Radioactive Decay Correction Factors
999-RH-13	Behavior of Certain Radionuclides Released into Fresh-Water Environments - Annual Report 1959-1960
999-RH-14	Iodine-131 in Children's Thyroids from Environmental Exposure
999-RH-15	Quality Control of Radioactivity - Counting Systems
999-RH-16	Medical Uses of Radium and Radium Substitutes
999-RH-17	Radionuclide Analysis of Large Numbers of Food and Water Samples
999-RH-18	Mortality of New England Dentists 192101960
999-RH-19	Soil and Sediment Analysis: Preparation of Samples for Environmental Radiation Surveillance
999-RH-20	Standards of Performance for Film Badge Services
999-RH-21	A Computer Program for the Analysis of Gamma-Ray Spectra by the Method of Least Squares
999-RH-22	Scientific Information Retrieval System for Research Grants
999-RH-23	Routine Surveillance of Radioactivity Around Nuclear Facilities
999-RH-24	Distribution of Cobalt 60, Zinc 65, Strontium 85, and Cesium 137 in a Freshwater Pond
999-RH-25	Radionuclide Standardization - A Bibliography
999-RH-26	Natural Environmental Radioactivity from Radon 222
999-RH-27	Radioassay Procedures for Environmental Samples
999-RH-28	Full Scale System for Removal of Radiostrontium from Milk
999-RH-29	Tritium Contamination in Particle Accelerator Operation
999-RH-30	Reduction of Radiation Exposure in Nuclear Medicine
999-RH-31	An Acclimation Room for the Detection of Low Radium 226 Body Burdens
999-RH-32	Common Laboratory Instruments for Measurement of Radioactivity
999-RH-33	Guidelines to Radiological Health

U. S. GOVERNMENT PRINTING OFFICE : 1969 O - 337-955

U.S. Department of Health, Education, and Welfare, Public Health Service Publication No. 999-RH-34 (1969) 95 pp. (limited distribution).

ABSTRACT. The Georgia Radium Management Project, a joint effort between the Radiological Health Service of the Georgia Health Department and the Radioactive Materials Section, Division of Radiological Health (presently Radioactive Materials Branch, Division of Medical Radiation Exposure, Bureau of Radiological Health), Public Health Service, determined the extent of the use of radium in medicine and the radiological health problems existing as a result of this use. Basically, the investigation concerned an assessment of (a) the extent and types of radium usage in the practice of medicine, (b) adequacy of radiation safety procedures and equipment employed in handling, storing, and using radium sources, (c) leakage of radium sources, and (d) contamination resulting from use of radium in

(over)

Contamination
Film badge
Insurance
Leakage
Patient treatment
Radiation safety
Radium
Sterilization
Storage
Survey procedures
Transport devices

BENSON, JAMES S., RICHARD H. FETZ, CECIL D. POSEY, and EARL W. ROBINSON: Georgia radium management project.

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ACCESSION NO.

KEY WORDS:

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THE ABSTRACT CARDS accompanying this report are designed to facilitate information retrieval. They provide space for an accession number (to be filled in by the user), suggested key words, bibliographic information, and an abstract. The key word concept of reference material filing is readily adaptable to a variety of filing systems ranging from manual - visual to electronic data processing. The cards are furnished in triplicate to allow for flexibility in their use.

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